REMARKS/ARGUMENTS

Response to rejections — 35 USC 102 and 103

Claims 1-9, 12, and 15-16 were rejected under 35 USC 102(b) as anticipated by US Pat. No. 5,757,912 ("Blow"). In addition, claims 10-11, 13-14, and 17-18 were rejected as being unpatentable over Blow. However, there are several significant features recited in the claims that are neither taught nor suggested by Blow.

Transmitter and two receivers vs. transmitter and one receiver

Claims 1-15 clearly recite a quantum key distribution system using one source that coherently splits each photon into two components and transmits the two coherent components to two receivers. Blow, however, does not teach these claimed features. In fact, cited col. 6, lines 10-14, of Blow explicitly teaches transmitting signals to "the receiver" (i.e., not two receivers but one receiver). As clearly shown in Blow's Fig. 3, for example, a single transmitter 1 sends photon pulses to a single receiver 2 which uses single-photon detectors 7 and 8 to perform measurements (col. 6, lines 12-15). The two detectors 7 and 8, however, are part of a single receiver 2.

In addition, although cited column 9, lines 3-6, of Blow teaches a "multiple access network connecting a plurality of receivers" (Fig. 6), the mere connection of multiple receivers on a shared network does not imply the claimed feature of transmitting two coherent components of a photon from the transmitter to two receivers. In fact, in further describing the embodiment of Fig. 6 in col. 9, lines 31-40, Blow discusses only one receiver that detects photons from the transmitter. Moreover, in col. 10, lines 51-54, Blow explicitly states that the multiple access system separately establishes a distinct secret sequence between the controller/transmitter and each terminal/receiver on the network. Thus, Blow's multiple access network with multiple receivers is merely a replication of Blow's point-to-point technique between the transmitter and a single receiver. Nowhere does Blow teach that two coherent components of a photon are transmitted from the transmitter to two of these receivers, as recited in the present claims 1-15.

Key determined by two receivers vs. key determined by transmitter and receiver

Claims 1-8 explicitly recite a method in which two receivers jointly determine a quantum key from two coherent components of a photon. In contrast, Blow's system determines a quantum key between the transmitter and a single receiver. The Action cited col. 10 (no lines specified in the Action) as allegedly teaching the joint determination of a key by the two receivers. However, in col. 10, lines 51-54, Blow explicitly states that the multiple access system separately establishes a distinct secret sequence between the controller/transmitter and each terminal/receiver on the network. Nowhere does Blow teach joint determination of a key at two receivers from two coherent components of a photon transmitted from a transmitter, as claimed.

Blow does not teach two photons generated with random relative phase

Claims 2, 9-18 teach the sequential generation of two photons with random relative phase. The Action cites col. 3, lines 21-27 of Blow as allegedly teaching this limitation. However, this passage of Blow describes how "each single-photon signal is split and passes through two paths, only one of the two paths including a phase or polarization modulator." In other words, the cited passage relates to the relative phases between two components of a single photon; it does not relate to the relative phases between two distinct photons. Moreover, neither the cited passage nor any other portion of Blow teaches or suggests the generation of two photons having random relative phases, as claimed.

Blow does not teach two coherent components sent to two different receivers

Claims 1-18 teach coherently splitting each photon into two coherent components and transmitting the two coherent components, respectively, to two receivers. The Action cites col. 6, lines 10-14, as allegedly teaching this claimed limitation. In fact, however, cited col. 6, lines 10-14, of Blow teaches splitting the photon "at the receiver." Although Blow teaches splitting a photon at the transmitter coupler (col. 6, lines 4-5), Blow also teaches that the two components are recombined at the transmitter and subsequently sent through a single transmission line (col. 6, lines 10-11, Fig. 3) to a single receiver. In the claimed invention, in contrast, the two components are not recombined at the transmitter. Instead, the two components are sent to two respective receivers. Thus, Blow does not teach splitting a photon at the transmitter and sending two components to two respective receivers, as claimed.

Receiver with phase-modulated interferometer vs. receiver with time-shift interferometer

Claims 9-15 teach that each receiver includes an interferometer having two arms with relative optical path difference substantially equal to the time interval Δt. The Action alleges that this limitation is taught by Blow in col. 10, lines 10-19. This cited passage, of Blow, however, relates to a pulse timing regulator, and does not mention or relate at all to the relative path difference of the receiver interferometer. Thus, Blow does not teach the claimed limitation in the cited passage.

Similarly, claims 1-8 recite that each receiver generates from each component of each photon a coherent superposition of time-shifted states having a relative time shift of Δt. The Action alleges that this claimed feature is taught by Blow in col. 10, lines 1-5. This cited passage, however, merely states that the photon pairs must be associated with a given clock period, and identified as 0 or 1 depending on the state of the modulator. The cited passage does not teach that a coherent superposition of time-shifted states with relative time shifts are generated by the receiver, as claimed.

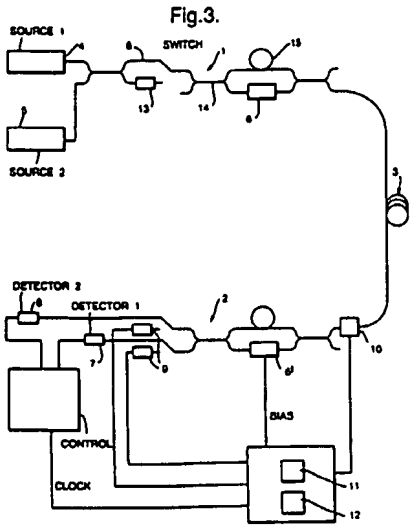
In fact, Blow teaches that the receiver's interferometer has a modulated phase shift of 0 or π (col. 5, lines 5-14) which is not related to any time shift. Blow does teach a path length difference corresponding to a time delay, but it is after the phase-modulating interferometer: "At the receiver the pulses are again split between two paths, one including a fibre delay and the other including a phase modulator. Signals from the two branches are then recombined and output to two single-photon detectors 7, 8. As with the laser sources, the detectors are connected to this system by paths of different lengths providing a delay complementary to that introduced at the source" (col. 6, lines 12-18). Thus, Blow does not, in fact, teach or suggest the feature that each receiver includes an interferometer having two arms with relative optical path difference substantially equal to the time interval Δt (claims 9-15), or that each receiver generates from each component of each photon a coherent superposition of time-shifted states having a relative time shift of Δt (claims 1-8).

Blow does not teach polarization-independent operation

In regards to claim 4, the Action alleges that Blow teaches that the receivers have polarization-independent operation in col. 10, lines 25-30. On the contrary, the cited passage states that "active polarization control will be required." Active polarization control would not be required if the receiver operation were independent of polarization. Thus, Blow does not, in fact, teach that the receivers are polarization-independent.

Summary

It has been shown in detail above that many significant aspects of the claimed invention are not, in fact, taught or suggested by Blow. A comparison of Fig. 3 of Blow with FIG. 2 of the present invention may be used to illustrate some of these differences:



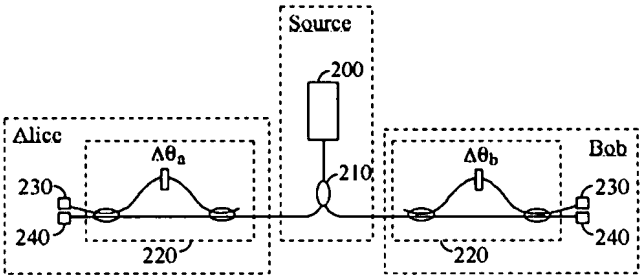


FIG. 2

As is evident from these figures, Blow's system has an interferometer at the transmitter that phase-modulates one component of a photon before the photon is sent to a single receiver. In contrast, the invention simply splits a photon at coupler 210 and sends the resulting two coherent components to two respective receivers. In addition, Blow's system establishes a secret key between the transmitter and the receiver, while the claimed invention establishes a secret key between the two receivers. The two systems are thus fundamentally different in design and operation. Other significant differences are that Blow does not teach generation of photons with random relative phase, Blow does not teach polarization-independent operation of the receiver,

and Blow does not teach a receiver interferometer whose arms have a relative path difference corresponding to the time shift.

In view of the significant differences between the claimed invention and Blow as described above, Applicant submits that Blow does not, in fact, teach or fairly suggest the invention as specifically recited in the claims. Accordingly, Applicant respectfully requests that the rejections be withdrawn and a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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